Eastern Interconnect Baseline Data Analysis

PNNL portion of the PJM/EPG/PNNL project

►Tom Ferryman, PhD
►Brett Amidan, MS

June 2010

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

Goals

► **Estimate typical and atypical limits of phase angle difference between pairs of sites**

- Analyze datasets to identify
    1. typical angle difference patterns over different periods (e.g. seasonal patterns, on-peak/off-peak patterns);
    2. atypical patterns;
    3. precursors to significant events; and
    4. phase angle clusters.
- Correlate atypical patterns and events to grid conditions (e.g. transmission system congestion, var support, outages etc) using associated system information.
- Suggest list of angle difference pairs to be monitored in real-time and their alarming limits.

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

Approach

►Two approaches
- ■Statistical Quality Control investigation
  - ●Uses ANOVA with
    - ◆Seasonal factors (4,6,13 seasons)
    - ◆Day of Week (7 days or weekdays/weekends)
    - ◆Time of Day (eight 3-hour periods)
    - ◆Holiday
    - ◆Interactions (maybe)
  - ●Calculate recommended limits using SQC practices
- ■Adapt Morning Report Analysis
  - ●Multivariate statistical analysis of datasets to identify
  - ●Refine work completed to date
  - ●Capture typical patterns (phase angle clusters)
  - ●Identify atypical events

►Investigate precursors to significant events

In work

Preliminary

To be done

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

Atypicality Plots
June 2008 to September 2008

Atypicality Plots
October 2008 to January 2009
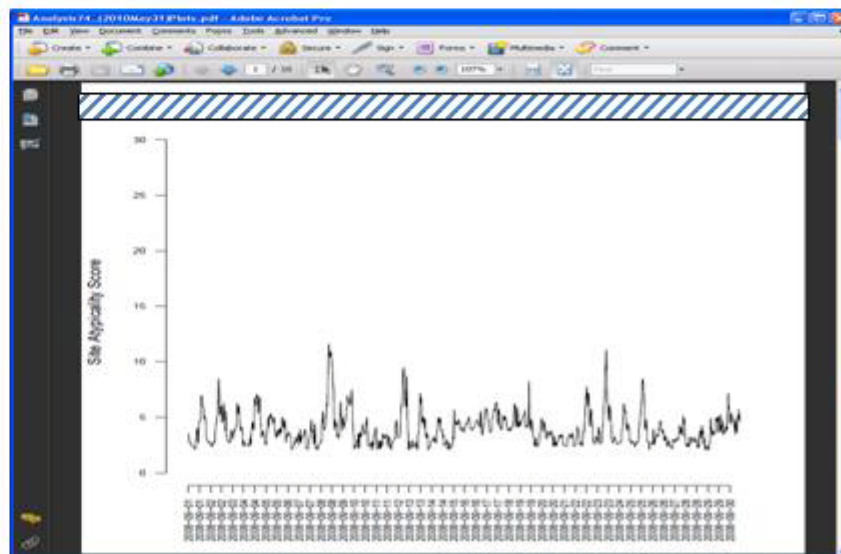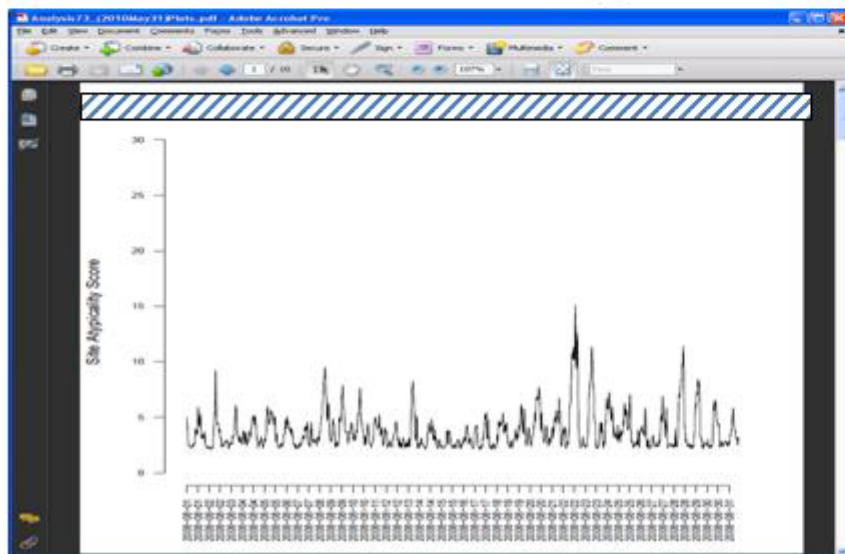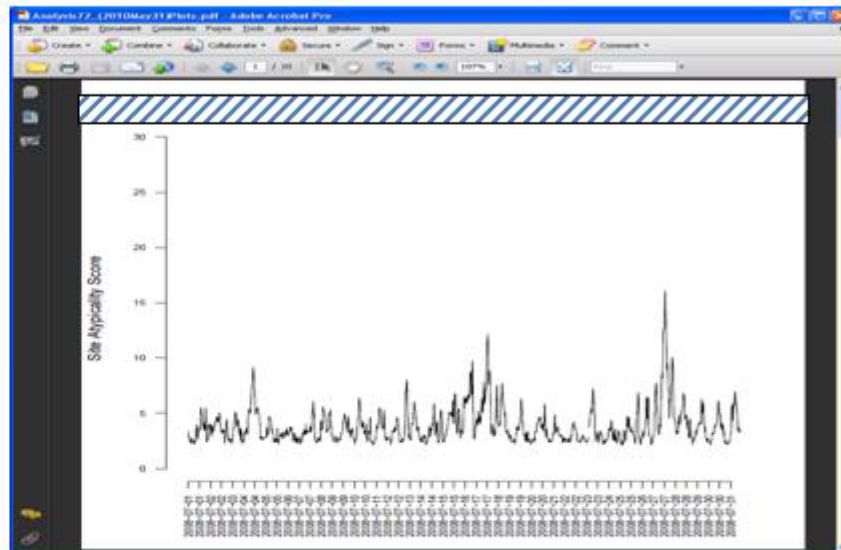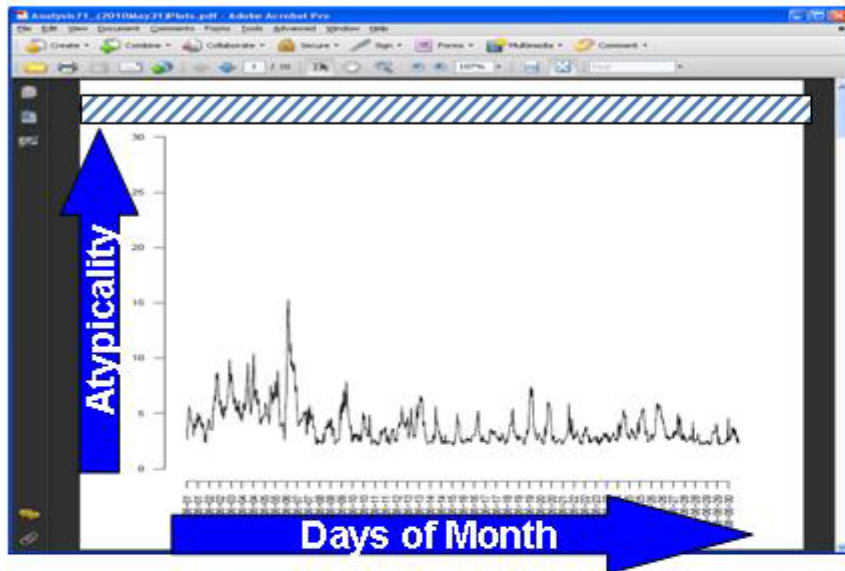
Atypicality Plots
February 2009 to May 2009
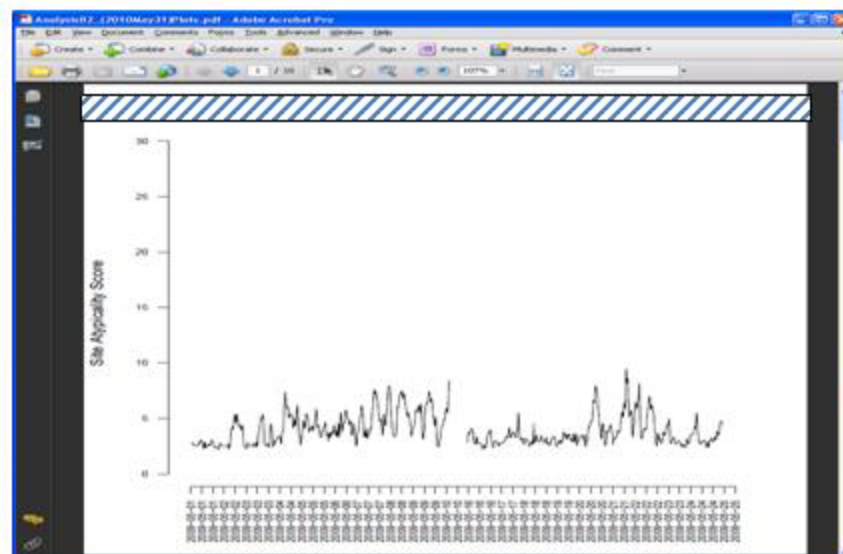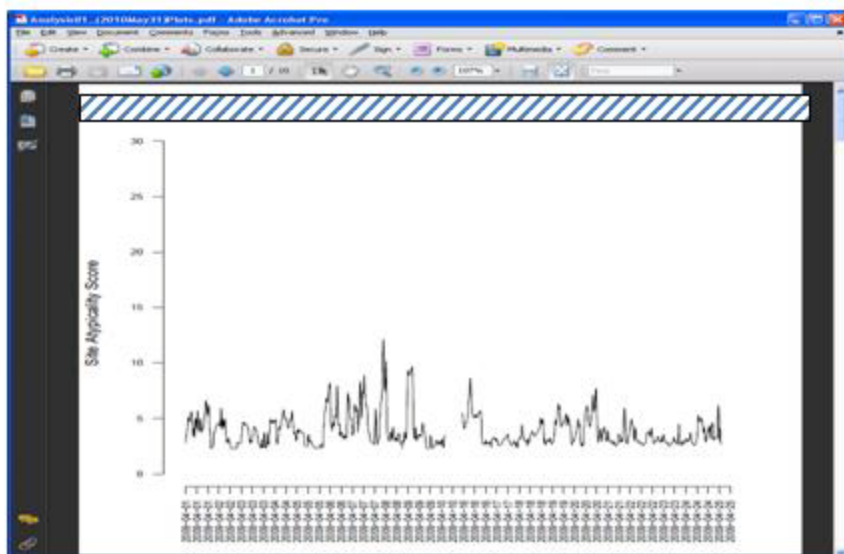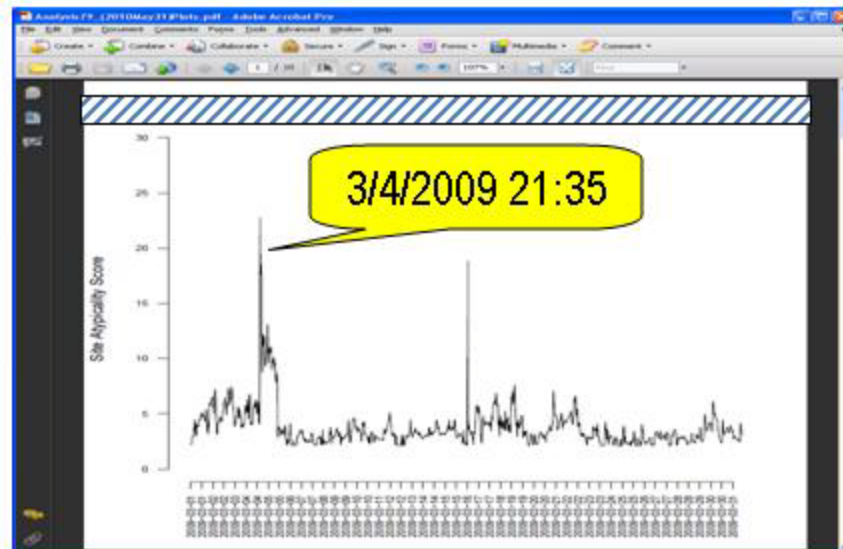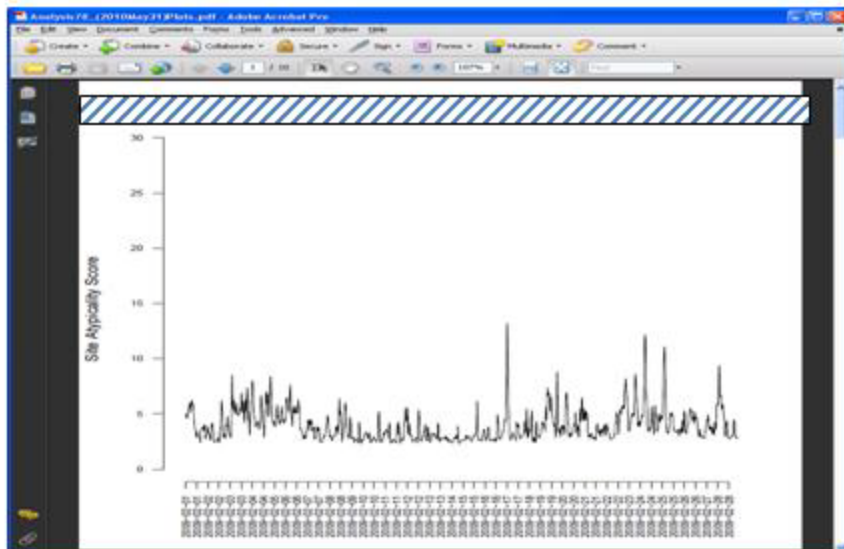
Rationale circa November 25, 2008 18:20
When Atypical events are detected.
What made them standout as atypical.

Drill down plots
74 hours centered around 25-nov-2008 ~18:20:00

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by Battelle Since 1965
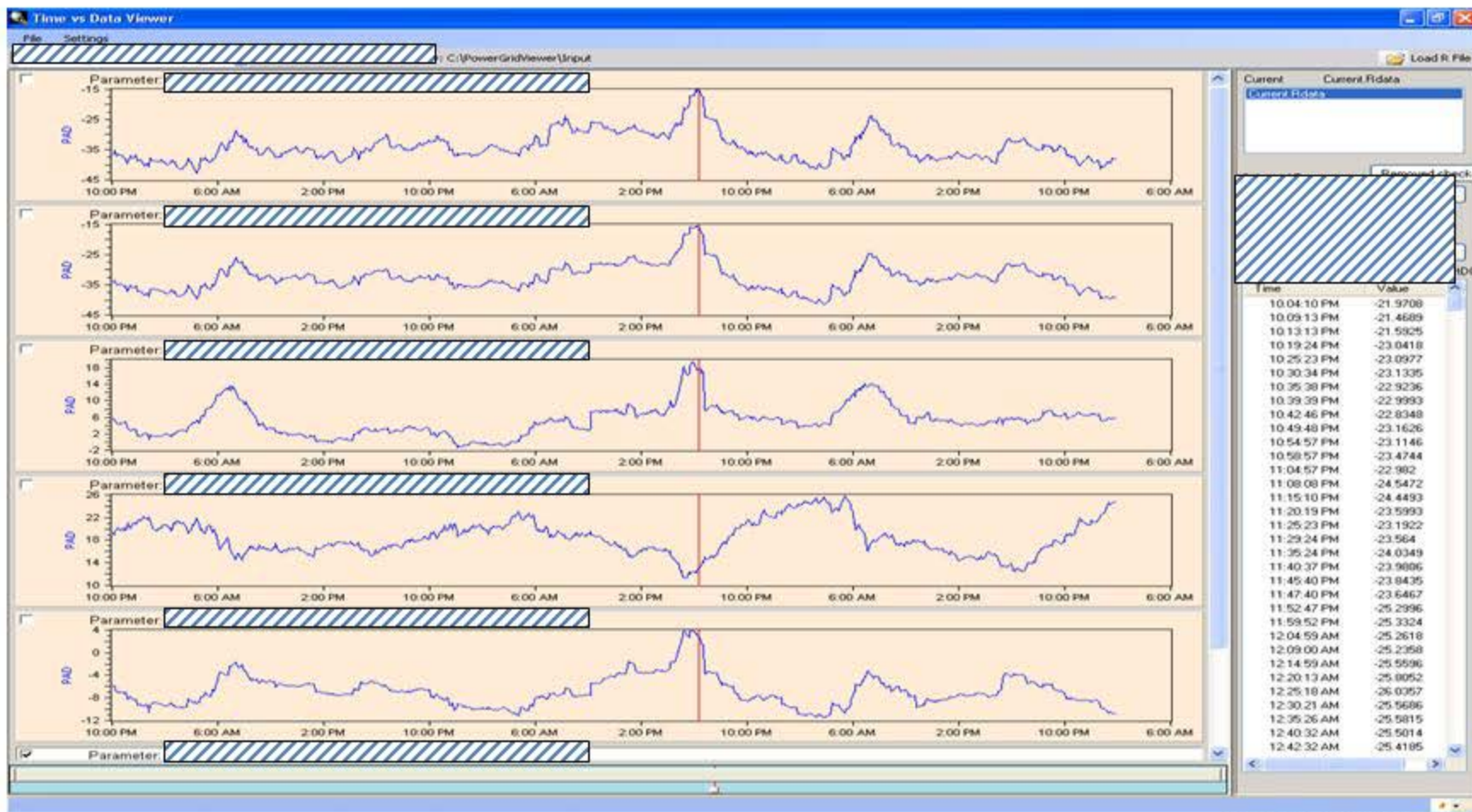
Drill down plots zoomed in
9 hours centered around 25-nov-2008 ~18:20:00
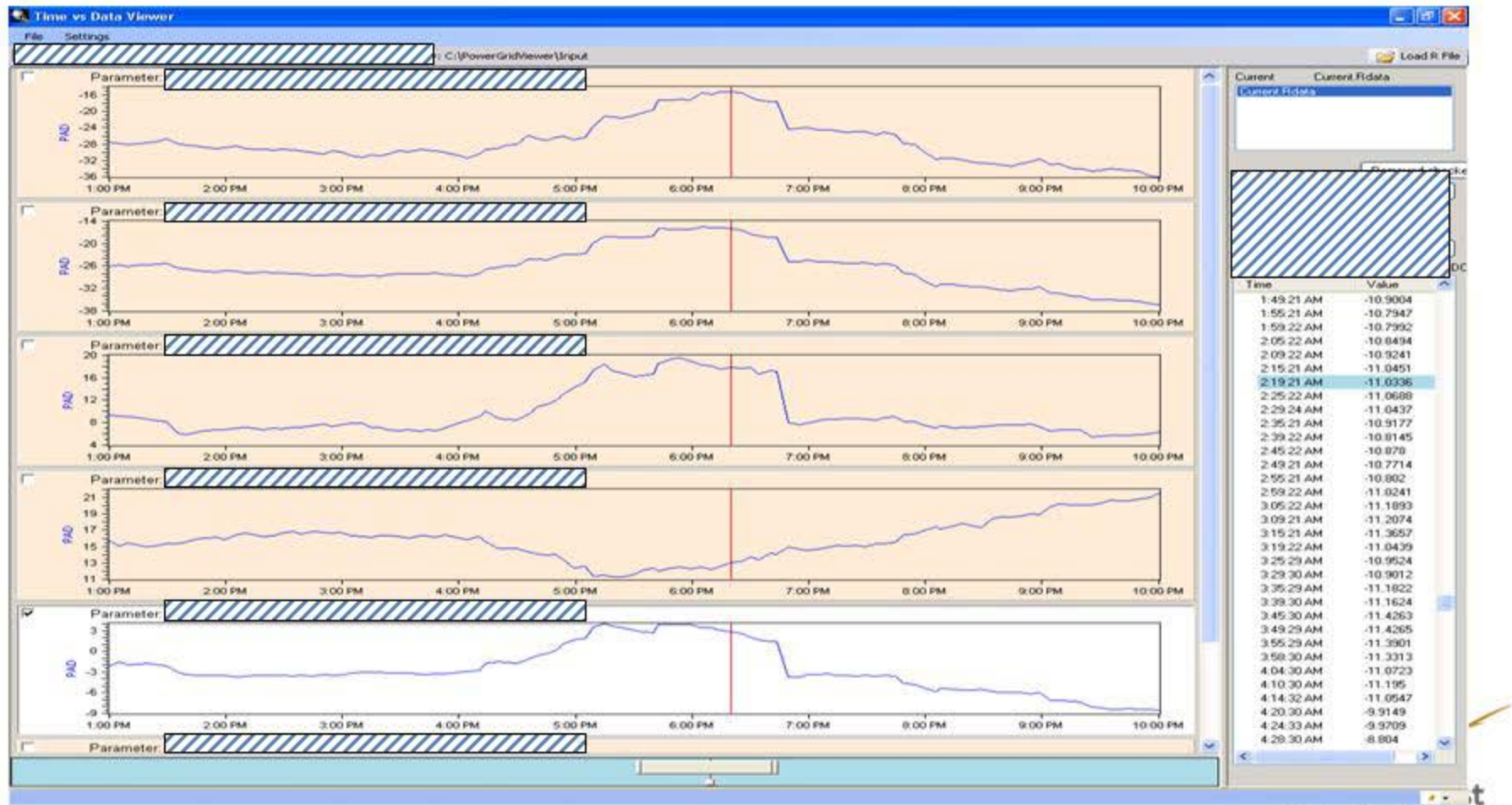
Rationale circa March 4, 2009 21:35
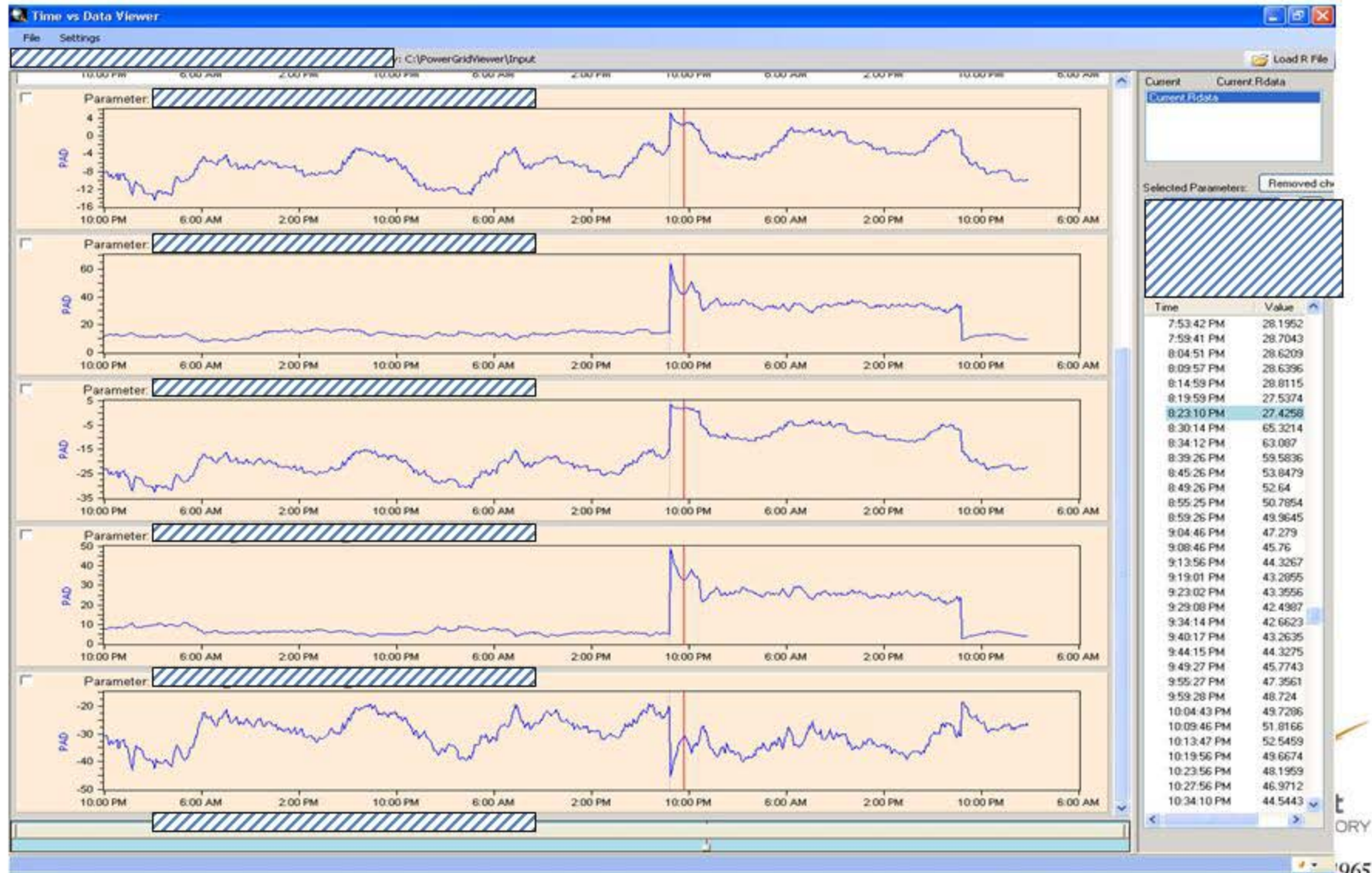## When Atypical events are detected.
What made them standout as atypical.

74 hours centered around 4-March-2009 ~21:35

74 hours centered around
4-March-2009 ~21:35

Zoom in   38 hours centered around 4-March-2009 ~21:35

~24 hour duration

Much is yet to be done

▶ SQC process investigation
  - Need to refine preliminary work

▶ Multivariate statistical analysis of datasets to identify
  - Need to refine preliminary work
  - Capture phase angle clusters

▶ Investigate precursors to significant events

▶ Correlate atypical patterns and events to grid conditions (e.g. transmission system congestion, var support, outages etc) using associated system information.

▶ Suggest list of angle difference pairs to be monitored in real-time and their alarming limits.